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Comparison of four postoperative pain evaluation scales in dogs undergoing ovariohysterectomy

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Abstract

This study aimed to compare four pain scales, including simple descriptive scales (SDS), visual analog scale (VAS), the University of Melbourne Pain Scale (UMPS), and the short form of Glasgow Composite Pain Scale (GCPS-SF) to assess postoperative pain in dogs that underwent ovariohysterectomy (OHE). Twenty-two female mixed-breed dogs were allocated into three treatments to receive incisional (n=7), transverse abdominis plane (TAP, n=7), and rectus sheet (RS, n=8) blocks. After premedication with acepromazine (0.05 mg/kg) and morphine (0.5 mg/kg), anesthesia was induced (4 mg/kg) and maintained (0.4 mg/kg/min) with propofol. Each dog randomly received one analgesic method, and then OHE was performed. Postoperative analgesia was evaluated up to 6 hours after the operation with the above-mentioned pain scales. The results showed that with the GCPS-SF, the scores at 4, 5, and 6 hours after surgery in the Incisional and RSB were higher than the baseline. In the UMPS, in the RSB, at 2, 3, 4, 5, and 6 hours after surgery, the pain score was significantly higher than the baseline. With the VAS, the pain score in the RSB was higher than the baseline at 3, 4, 5, and 6 hours after surgery. In the SDS, the Incisional and RS pain scores were higher at 3, 4, 5, and 6 hours after surgery than the baseline values. In conclusion, the UMPS might detect pain earlier and is more sensitive than the other three methods. Further studies should be done to confirm the results.

Key words: Glasgow Composite Measuring Pain Scale, University of Melbourne Pain Scale, Visual Analog Scale, Simple Descriptive Scale, Ovariohysterectomy

Introduction

As a part of standard medical practice, veterinarians must relieve pain and suffering of their patients. The definition, recognition, and management of pain may be challenging in dogs and cats. Veterinarians must recognize pain and administer adequate analgesics for ethical reasons related to animal welfare and to diminish postoperative complications such as immunosuppression or self-trauma. Therefore, pain assessment should be a standard physical examination component for every patient undergoing surgical procedures.

Various methods have been developed to assess pain in small animals, which rely on

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physiological and behavioral changes. However, these methods have limitations, as relying only on physiological variables is insufficient, and depending solely on behavioral changes can be subjective among veterinarians. As a solution, numerical pain scoring systems were developed as a more objective tool for pain quantification by interpreting both behavioral and physiological changes (Fowler et al, 2003; Hernandez-Avalos et al, 2019). These scoring tools allow for more reliable pain assessment and reduce observer subjectivity and bias (Epstein et al, 2015).

The Simple Descriptive Scale (SDS) is a pain scoring system that uses numbers from 0 to 3 to indicate the pain level, ranging from no to severe. However, this scale may not be sensitive enough to detect slight changes in pain intensity (Grimm et al, 2015). The Visual Analog Scale (VAS) is a 10 cm straight line labeled on both ends, with one end indicating no pain and the other showing severe pain. In veterinary medicine, since animals cannot assess their own pain, the observer determines the degree of pain (Hernandez-Avalos et al, 2019). The Glasgow Composite Measuring Pain Scale (GCPS) is a scoring system based on evaluations of spontaneous behavior, interactions with animals, and clinical observations. A shorter version of this scale (GCPS-SF) was developed for routine clinical use, emphasizing speed, ease of use, and guidance for analgesia provision (Holton et al, 2001; Reid et al, 2007). The University of Melbourne Pain Scale (UMPS) is a multidimensional scale used to evaluate dogs' pain by focusing on their behavior and physiological constants. This scale considers six variables: physiological constants, auscultation response, activity, emotional state, posture, and vocalizations (Firth et al, 1999; Hernandez-Avalos et al, 2019; Saritas et al, 2015).

To the knowledge of the authors, there is no report of comparison of these four pain scales in dogs to recognize if there is any difference between scales or if any scale is more accurate, practical, and valuable to assess postoperative pain in dogs. Therefore, the objective of the current study was to compare SDS, VAS, GCPS-SF, and UMPS in dogs anesthetized with propofol and underwent ovariohysterectomy (OHE).

Material and Methods

In this study, 22 dogs were selected based on their physical status (ASA I-II) and body condition score (3-6 on a scale of 1-9). These dogs weighed an average of 19.3 ± 2.7 kg and were between 1.5-2.5 years old. The dogs underwent a thorough physical examination, CBC, and TP measurements to ensure their health status before being transferred to the Veterinary Hospital. They were kept in individual cages for at least two weeks before the study. The dogs were fed twice a day and provided water ad libitum, with a fasting period of 12 hours and water limitation for 2 hours before each experiment.

On the day of the experiment, the dogs were given premedications of acepromazine (0.05 mg/kg; Neurotranq, Acepromazine maleate, Alfasan, Holland) and morphine (0.5 mg/kg; Morphin Sulfate, 10 mg/mL, Darou Pakhsh, Iran) through intramuscular injection. After 20 minutes, a 20 gauge intravenous catheter was aseptically inserted into the left saphenous vein, and a lactated ringer's solution infusion was started at a rate of 5 mL/kg/hr. Propofol (6 mg/kg; Pofol, Propofol 1%, Dong Kook Pharm, Chng Cheong, Korea) was given intravenously (IV) to induce anesthesia, which was adjusted according to the effect. Following tracheal intubation, all dogs were connected to a re-breathing system and given 100% oxygen, initially at 30 mL/kg/min for 10 minutes and then 10 mL/kg/min. Anesthesia was maintained with a constant rate infusion of propofol (0.4 mg/kg/min) using a syringe pump

(Daiwha, Medifusion, Gangnam-gu, Seoul, Korea). Throughout anesthesia, various variables such as heart rate (HR), non-invasive systolic, diastolic, and mean blood pressure (SBP, DBP, and MBP), respiratory rate (f_R), rectal temperature (RT), end-tidal carbon dioxide (ETCO2, Capnograph, Respironics, USA), and peripheral arterial oxygen saturation (SPO2) were continuously monitored using a multiparameter monitor (Trismed, Vitapia 7000k, Daejeon, Korea). The baseline values for these parameters were recorded 5 minutes before surgery commenced.

During the experiment, the dogs were breathing on their own, but if the levels of EtCO2 fell outside the normal range (35-45 mmHg), manual ventilation was used to restore them. Rectal temperature was maintained at 37-38ºC, achieved via a heating pad and warm water. After 15 minutes, the surgical area was meticulously cleaned using an aseptic technique.

Following standard procedures, an ovariohysterectomy was carried out routinely. If any limb movement was observed during the operation, propofol (1 mg/kg) would be administered. If HR or BP increased by 20% or more compared to baseline values, one mcg/kg fentanyl (Fentanyl citrate, 0.5 mg/10 mL, Caspian Tamin Pharmaceutical, Rasht, Iran) would be given intravenously (IV), up to a maximum of two doses. If these parameters did not improve, a continuous infusion of fentanyl at a rate of 0.5 mcg/kg/hr would be initiated.

The dogs were randomly assigned one of the three treatments: incisional (Incisional, n=7), Transverse Abdominis Plane (TAP; n=7), or Rectus Sheath (RS; n=8) blocks. All dogs were placed in dorsal recumbency, and the skin from the pubis to the xiphoid and laterally to 10 cm on either side of the ventral midline was shaved and prepared aseptically before block administration.

Incisional, TAP, and RS blocks were done according to methods described elsewhere. Briefly, for incisional line block, bupivacaine 0.25% (1 mg/kg; Bupivacaine HCL 0.5%, Mungmoon Pharm, Seoul, Korea) diluted to 0.8 mL/kg, injected in an 8cm line using a 20-gauge, 2-inch hypodermic needle (Fitzpatrick et al. 2010). For the TAP block using an ultrasound (Landwind, Wellkang tech. Shenzhen, China) to identify the layers of the abdominal wall, a 22-gauge 90-mm spinal needle (Disposable spinal needle, Dr. Japan), attached to an extension set, was inserted into the facial plane between the internal abdominal oblique and transversus abdominis muscles and then Bupivacaine 0.25% (1 mg/kg, diluted to 20 mL with normal saline) was injected in both sides of the abdomen (Schroeder et al., 2011). For the RS block, with the aid of ultrasound, a spinal needle (22 gauge, 90 mm) was inserted into the plane between the internal rectus sheath and the rectus abdominis muscle, and a bupivacaine 0.25% (0.5 mL/kg) was injected into both sides of the abdominal wall (James et al., 2010).

A single individual (H.I.R) administered all injections, while an experienced veterinarian performed all surgeries. The same investigator (M.K) recorded and measured the data. Intraoperative analgesia assessment involved monitoring parameters such as HR, blood pressure, propofol consumption, and frequency of injected fentanyl. Postoperative analgesia was evaluated using the GCPS-SF, UMPS, VAS, and SDS assessed independently by two individuals blinded to the treatment (MK and MEG). If the pain score exceeded 5/20 or 6/24 in the GCPS-SF or 8 in the UMPS or was greater than 3 in the VAS, fentanyl would be administered intravenously (IV) at a dose of 1mcg/kg, with each animal allowed to be injected up to two times at most. Ketoprofen (1.1 mg/kg; Ketoprofen 1%, Rooyan Daroo, Tehran, Iran) was administered to all animals at the end of the study.

The data were analyzed using GraphPad Prism software version 9.0.0. Agreement between researchers for given pain scores was checked using the Weighted kappa coefficient. The correlation was evaluated based on Altman's model (1990) as very good (K=0.81-1.00), good (K=0.61-0.80), moderate (K = 0.41-0.60), relatively weak (K=0.21-0.40), and weak (K<0.20). The normal distribution of the data was evaluated by the Shapiro-Wilk test. The Friedman test was employed for statistical analyses. Data were expressed as median (minimum-maximum). The significant level was considered at P<0.05.

Results

All animals tolerated the analgesia, anesthesia, and surgery procedures well and completed the study. Table 1 provides the results of the pain scores after the operation. The inter-rater agreement among the observers was very good (K=0.92).

Table 1: Median (minimum and maximum) of the pain score in the postoperative period in dogs undergoing OHE under constant rate infusion of propofol receiving incisional (Incisional, n=7), transverse abdominal plane (TAP, n=7) and rectus sheath (RS, n=8) blocks

Groups		baseline	30 minutes	1 hour	2 hr	3 hr	4 hr	5 hr	6 hr	*p* value
Composite Measuring Pain Scale-Short Form (GCPS - SF)	Incisional	0 (0-5)	1 (0-7)	1 (0-7)	3 (2-10)	4 (3-11) £	6 (3-11) *, §	6 (5-11) *, £	6 (5-11) *, †, £, §	0.0001>
	TAP	0 (0-3)	1 (0-4)	1 (0-7)	1 (0-8)	3 (0-4) £	3 (0-4) §	4 (1-6) *, £	4 (1-6) *, £, §	0.0066
	RSB	0 (0-2)	1.5 (0-4)	1.5 (0-6)	2 (1-6)	3.5 (1-8) £	4 (0-11) *, §	5 (1-11) *, £	5.5 (3-11) *, £, §	0.0001>
	p value	0.6993	0.9331	0.9261	0.3368	0.5803	0.1223	0.0919	0.0284	
The University of Melbourne Pain Scale (UMPS)	Incisional	0 (0-7)	1 (0-8)	2 (3-9)	5 (3-9) ‡	5.5 (2-9) ‡	8 (4-9) *, ‡	8.5 (5-9) *, †, ‡	9 (5-9) *, †, £, §	0.0001>
	TAP	0 (0-1)	1 (0-7)	1 (0-11)	1 (0-11) ‡	4 (0-7) ‡	4 (1-7) ‡	5 (1-6) *, ‡	5 (1-7) *, £, §	0.0039
	RSB	0 (0-4)	2 (0-4)	2 (0-5)	5 (1-7) *, ‡	5 (1-9) *, ‡	5 (0-9) *, ‡	6 (2-10) *, ‡	7 (4-10) *, £, §	0.0001>
	p value	0.5649	0.8725	0.9845	0.2210	0.3213	0.0504	0.0195	0.0175	
Visual Analogue Scale (VAS)	Incisional	1 (0-3)	1(0-4)	1 (0-4)	2 (1-4) £	2.5 (1-4)	3 (2-5) *	4 (3-5) *, †	4 (3-5) *, †	0.0001>
	TAP	0 (0-3)	1 (0-3)	1 (1-4)	1 (1-2) £	2 (1-3)	2 (0-3)	2 (1-3)	2 (1-3)	0.0657
	RSB	0 (0-1)	1 (0-3)	1.5 (1-3)	2 (1-4) £	2.5 (1-3) *	3 (0-4) *	3 (0-4) *	3.5 (2-4) *	0.0001>
	p value	0.3045	0.9834	0.9163	0.2564	0.4657	0.1825	0.0129	0.0031	
Simple Descriptive Scale (SDS)	Incisional	0 (0-2)	1 (0-3)	1 (1-3)	1.5 (1-3)	2 (1-3) *	3 (2-3) *	2.5 (2-3) *	3 (2-3) *	0.0001>
	TAP	0 (0-1)	0 (0-3)	2 (0-3)	1 (0-3)	2 (0-3)	2 (0-3) *	2 (0-3) *	2 (1-3) *	0.0001>
	RSB	0 (0-1)	0 (0-2)	1 (0-3)	2 (0-3)	2 (1-3) *	2 (1-3) *	2 (1-3) *	3 (2-3) *	0.0012
	p value	0.5802	0.6111	0.9376	0.6578	0.6941	0.6255	0.3148	0.2908	

* Significantly different from baseline (P<0.05), † Significantly different from the TAP treatment (P<0.0.5), ‡ Significantly different from other pain scales (P<0.05), £ Significantly different from the SDS (P<0.05), § Significantly different from the VAS (P<0.05).

Comparison of the pain scores within each treatment showed that with the GCPS-SF, the scores at 4, 5, and 6 hours after surgery in the Incisional were higher than the baseline (P=0.0257, 0.0016, and 0.0010, respectively). The TAP treatment's pain score at 5 and 6 hours after surgery was significantly higher than the baseline (P=0.0090). The pain scores at 4, 5, and 6 hours after surgery in the RSB were also significantly higher than the baseline (P=0.0109, 0.0001, and 0.0001, respectively). In the UMPS, in the Incisional, at 4, 5, and 6 hours after surgery, the pain score was significantly higher than the baseline (P=0.0102, 0.0011, 0.0007, respectively). In the TAP, at 5 and 6 hours after surgery, the pain score was significantly higher than the baseline (P=0.0109 and 0.0018, respectively). In the RSB, at 2, 3, 4, 5, and 6 hours after surgery, the pain score was significantly higher than the baseline (P=0.0348, 0.0208, 0091, 0.0013, and 0.0001, respectively). With the VAS, the pain score was significantly higher in the Incisional at 4, 5, and 6 hours compared to the baseline (P=0.0393, 0.0055, and 0036, respectively). Also, the pain score in the RSB was higher than the baseline at the 3, 4, 5, and 6 hours after surgery (P=0.0410, 0.0215, 0.0044, and 0.0001, respectively). In the SDS, the pain scores were higher than the baseline values at 3, 4, 5, and 6 hours after surgery (P=0.0025, 0.0036, 0.0017, and 0.0003, respectively). The pain scores in the TAP were significantly higher than baseline at 4, 5, and 6 hours after surgery (P=0.0091, 0.0076, and 0.0007, respectively). In the RSB, the pain scores were higher at 3, 4, 5, and 6 hours after surgery compared to the baseline values (P=0.0254, 0.0025, 0.0009, and 0.0005, respectively).

Comparison of the pain scores among treatments showed that with the GCPS-SF, the pain score at 6 hours after surgery was significantly higher in the Incisional than in the TAP (P=0.0057). In the UMPS, the pain score at 5 and 6 hours after surgery in the Incisional was significantly higher than the TAP (P=0.0209 and 0.0249, respectively). With the VAS, the pain scores at 5 and 6 hours after surgery in the Incisional were significantly higher than in the TAP (P=0.0143 and 0.0065, respectively).

In comparison among the pain scores at 2, 3, 4, and 5 hours after surgery, the UMPS had the highest score than the GCPS-SF, VAS, and SDS (P<0.01). VAS and SDS are different from each other (P<0.01). At 3 hours, there was a significant difference between the GCPS-SF and SDS (P<0.001). At 4 hours after surgery, the GCPS-SF differed significantly from the VAS (P<0.01). At 5 hours, Comparing GCPS-SF and SDS showed a significant difference (P<0.001). At 6 hours after surgery, the UMPS and GCPS-SF had significant differences with the VAS and SDS (P<0.001).

Discussion

The present study used four pain scales and scoring methods to evaluate dog analgesia after ovariohysterectomy. The results showed that all four procedures can be easily performed in dogs. The UMPS detected pain faster than other scales. It appeared that VAS might detect pain faster than GCPS-SF; however, VAS did not show pain in the TAP treatment.

The pain changes the animal's behavioral and physiological responses to reduce or eliminate the possibility of injury and improve recovery. Although there are inter-individual and inter-species differences, some behaviors that change in animals in pain include: behavior patterns, appearance, posture, gait, appetite, and touch response. The difficulty in diagnosing pain has been mentioned as one of the main reasons for not administering enough analgesics (Anil et al, 2002). Testing the validity of pain scales is inherently difficult because there must be a gold standard to which comparisons can be made. VAS is considered the gold standard in humans because it is a self-reporting scale. Since it is impossible for an animal patient to report their pain, a trained observer must do a pain assessment (Williams et al, 2000). Currently, there is no universally accepted gold standard technique for pain assessment in veterinary medicine.

Pain scaling systems can generally be divided into unidimensional and multidimensional methods. In the unidimensional approach like SDS and VAS, the observer should give a pain score to an animal according to their impression. As a result, they are utterly dependent on the observer evaluation which might differ widely among various individuals. In contrast, multidimensional approaches like GCPS-SF and UMPS use behavior and physiologic parameters to score the pain and are less dependent on the observer. The current study used SDS, VAS, GCPS-SF, and UMPS to evaluate pain in dogs who underwent OHE.

The SDS and VAS methods are designed based on observing dogs' behaviors and physical states. Although heart rate and respiratory rate changes are discussed in the VAS, they have no particular point. The GCPS-SF and UMPS methods are multidimensional scales; however, physiological factors play a more definitive role in the UMPS than GCPS-SF. The GCPS-SF is a modified and simplified form of the Glasgow Composite Measuring Pain Scale (GCPS), introduced by Reid et al. (2007). It has also been stated that the GCPS can differentiate between mild, moderate, and severe pain in both soft and hard tissues (Murrell et al. 2008). For instance, an increase in heart and respiratory rates lead to an increase in the total score in UMPS but have no point in the GCPS-SF (Hernandez-Avalos, 2019).

In the previous investigations, one (Portela et al, 2014; Campoy et al, 2022), two (Carpenter et al, 2004; Fitzpatrick et al, 2010; Campagnol et al, 2012; Cavaco et al, 2022) or three (Lambertini et al, 2018) pain scoring scales were used. Holton et al, (1998) compared VAS, SDS, and NRS to evaluate acute pain in dogs and concluded that the NRS method was the most appropriate clinical method when there was more than one observer; but in total more than one observer can produce a high amount of variability in scores (Carpenter et al, 2004). Carpenter et al, (2004) used VAS and composite pain scale (CPS; based on UMPS) approach and stated that VAS was more reliable than CPS. Campagnol et al, (2012) scaled the pain using VAS and numeric rating scales (NRS) and found that, except for one hour, pain in VAS and NRS was similar. Lambertini et al. (2018) utilized three pain scales, including GCPS-SF, dynamic interactive visual analog scale (DIVAS), and mechanical nociceptive threshold (MNT). They found that GSPS-SF had higher ranges than others, but DIVAS and MNT had no difference. GCPS-SF was the only scale able to see a difference at higher time points. Cavaco et al, (2022) used NRS and GCPS-SF, and they did not find significant differences in the results.

In the present study, UMPS showed a significant difference at 2, 3, 4, and 5 hours after the operation compared to other employed pain scales. The UMPS detected significant differences concerning pain scores at 2 hours after surgery; the other three methods were not so which may indicate that the UMPS can show pain faster than other pain evaluation methods. The SDS showed a significant difference in the Incisional treatments 3 hours after surgery which UMPS and VAS did not confirm. At 3 hours after the operation, the UMPS, VAS, and SDS delivered a significant difference from the baseline, but GCPS-SF did not. It might be because GCPS-SF is more accurate at higher time points, not the first few hours. The SDS showed a significant difference in the Incisional treatments 3 hours after surgery which UMPS and VAS did not confirm. The GCPS-SF, UMPS, and SDS showed significant differences at 4, 5, and 6 hours after the surgery in the three treatments compared to the baseline. The VAS showed no significant difference in the TAP treatments at all time points compared to the baseline which may be due to the ineffectiveness of the VAS in detecting pain in some dogs due to high dependency on the observer evaluation. For pain comparison among treatments, the UMPS and VAS showed significant differences between the Incisional and TAP treatments at 5 and 6 hours, while the GCPS-SF indicated a significant difference only at 6 hours post-operation.

In conclusion, it appeared that all four employed pain scale methods could be used relatively easily in dogs that underwent OHE. Although all four methods can be used reliably, it seems that the UMPS might detect the pain earlier and is a more sensitive method during 6 hours after the surgery compared to the other three methods.

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Conflict of Interest

The authors declare that they have no conflicts of interest.

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مقایسه چهار روش ارزیابی درد پس از عمل در سگ‌های تحت عمل جراحی برداشت رحم و تخمدان

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چکیده

هدف از مطالعه حاضر مقایسه ۴ روش ارزیابی درد شامل مقیاس توصیفی ساده (SDS)، مقیاس آنالوگ بصری (VAS)، مقیاس اندازگیری درد مرکب گلاسکو (GCPS-SF) و مقیاس درد دانشگاه ملبورن (UMPS) برای ارزیابی درد پس از عمل در سگ‌هایی که تحت عمل جراحی اوواریوهیسترکتومی قرار گرفتند، بود. بیست و دو سگ نژاد بومی به سه گروه بلوک خط برش (Incisional, n=7)، بلوک صفحه عرضی شکمی (TAP, n=7) و بلوک غلاف مستقیم شکمی (RSB, n=8) تقسیم شدند. پس از دریافت پیش‌بیهوشی با آسپرومازین (۰/۰۵ mg/kg) و مورفین (۰/۵ mg/kg)، بیهوشی با پروپوفول القا (۴ mg/kg) و نگهداری (۰/۴ mg/kg/min) شد. هر سگ به طور تصادفی یکی از روش‌های بی‌دردی را دریافت و سپس تحت عمل جراحی قرار گرفت. بی‌دردی پس از عمل تا ۶ ساعت پس از جراحی با روش‌های فوق‌الذکر بررسی شد. نتایج نشان داد که با روش گلاسکو، امتیاز درد در ساعات ۴، ۵ و ۶ پس از جراحی در بلوک خط برش و RSB بالاتر از زمان صفر بود. در روش ملبورن در گروه RSB در ساعات ۲، ۳، ۴، ۵ و ۶ پس از جراحی امتیاز درد بالاتر از زمان صفر بود. در روش VAS، امتیاز درد در بلوک RSB، در ساعات ۴، ۵ و ۶ پس از جراحی بالاتر از زمان صفر بود. در روش SDS، امتیاز درد بلوک خطی و RSB در زمان‌های ۳، ۴، ۵ و ۶ پس از جراحی نسبت به زمان صفر بالاتر بود. نتیجه‌گیری شد که روش UMPS می‌تواند درد را زودتر و با حساسیت بیشتری نسبت به سه روش دیگر نشان داد. برای اثبات نتایج نیاز به مطالعات بیش‌تر است.

کلمات کلیدی: مقیاس اندازه‌گیری درد مرکب گلاسکو، مقیاس درد دانشگاه ملبورن، مقیاس آنالوگ بصری، مقیاس توصیفی ساده، اوواریوهیسترکتومی

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